Tag, You're It!

Using Harmonic Radar To Track the Flight of Beetles

Meet the Scientist

Dr. Williams: ▼ One of my most interesting science experiences was placing tags on Asian long-horned beetles. Because the beetles eat through wood in their early life stages, they have very strong jaws. It takes two people to tie a tag on them, and you have to be very careful because when they bite they draw blood! In this photograph, Mr. Liu is helping me place a tag on a beetle.

Glossary:

entomologist (**en** to **mul** o jist): A scientist who studies insects.

native (**na** tiv): Naturally occurring in an area.

nonnative (nän **na** tiv): Not naturally occurring in an area.

habitat (**hab** uh tat): Environment where a plant or animal naturally grows and lives.

import (**im** port): To bring goods into one country from another.

larva (**lär** vuh): Wormlike feeding form that hatches from the egg of many insects.

pupa (**pyü** puh): Intermediate stage of insect growth between larva and adult.

manager (**ma** ni jür): A skilled person who directs or manages something.

average (**av** rij): The usual kind or amount. The number obtained by dividing the sum of two or more quantities by the number of quantities added.

antenna (an **ten** uh): A set of wires used to send and receive signals.

speculate (**spek** u lat): To think about or make guesses.

habitat (**hab** uh tat): Environment where a plant or animal naturally grows and lives.

Pronunciation Guide

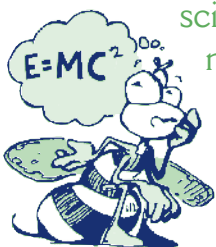| a | as in ape | o | as in go | ü | as in fur |
ä	as in car	ô	as in for	oo	as in tool
e	as in me	u	as in use	ng	as in sing
i	as in ice				

Accented syllables are in **bold.**

Thinking About Science

Technology is giving environmental scientists new ways to study the natural world. For *entomologists*, technology has enabled them to track the movements of flying insects. To track the movement of animals larger than insects, scientists use a transmitter placed on the animal that sends a signal to a receiver. For small flying insects, these transmitters are too heavy because they require a battery.

Entomologists are now using technology called harmonic radar. The scientist attaches a small metal tag to an insect. The tag reflects an electronic signal coming from a hand-held transceiver. (Transceiver is a combination of the words "transmitter" and "receiver" because the transmitter also receives the signal that is reflected off the tag.) This signal enables the scientist to locate the tag and, in this case, the insect to which the tag is attached. The reflected signal is the same for all tags, so the scientists must also mark the insects so that they can identify individuals. In this study, the scientist followed the flight of a beetle *native* to China.

Thinking About the Environment
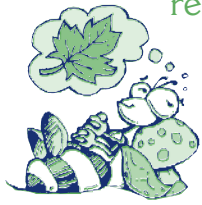
All animals move. Sometimes movement results in animals placing more distance between themselves and other animals. When animal movement results in more distance between individual animals, scientists call this dispersal (dis **pür** sul). For insects, dispersal is often the result of short flights, usually made when an insect is searching for food or new breeding sites for laying eggs. When the insect is a *nonnative* pest with eating or breeding behavior that can damage or kill plants, it is important to understand its dispersal.

In this study, the scientist traveled to China to study the dispersal of an insect pest that had recently been found in the United States. By observing the insect's dispersal in its native *habitat*, the scientist was able to better understand how its dispersal might occur in the United States.

Introduction

The Asian long-horned beetle is an insect pest that was discovered in New York in 1996 and Chicago in 1998 (**figure 1**). It arrived in the United States on wood packing material that was being used to *import* goods from Asia. The beetle lays its eggs under the bark of trees. As the *larva* and *pupa* develop, they use the tree for food. These activities can kill the trees. Fortunately, the beetle was quickly identified and destroyed in New York and Chicago.

Unfortunately, thousands of trees had to be removed from New York and Chicago to destroy the Asian long-horned beetle. Scientists estimate that if the Asian long-horned beetle had been allowed to disperse, it might have cost the United States more than $600 billion. The United States could have lost millions of trees if the Asian long-horned beetle had dispersed across the country.

Figure 1. Asian long-horned beetle. This beetle has been painted with a number so it can be identified for this study. What is this beetle's number?

One key to destroying the Asian long-horned beetle is to remove the trees. After removal, the trees are cut into small chips and then burned. To be successful in removing the trees to destroy the beetles, forest *managers* must know about how far the insect moves every day. As you read in "Thinking About the Environment," flying insects fly in search of food or places to lay their eggs. The scientist in this study wanted to know about how far an Asian long-horned beetle can fly every day.

Reflection Section

🍁 State in your own words the question the scientist wanted to answer through this research.

🍁 If the Asian long-horned beetle were found again in the United States, how would forest managers use the scientist's information to help them destroy the insects?

🍁 If a different insect pest were found in the United States, should forest managers use this information about the Asian long-horned beetle to tell them how far the insect might fly? Explain.

Method

The scientist traveled to China to study the Asian long-horned beetle. The area studied was located at latitude 39°23´ N. longitude 117°00´ E. The study site was about 80 kilometers southeast of Beijing (**figure 2**).

Number Crunches

🍁 How many miles southeast of Beijing was the study site? Multiply 80 by .621 to find out.

The scientist conducted his study on a row of existing trees. He found a row of 200 willow trees that were growing along a four-lane highway. Agricultural fields were on both sides of the highway. The trees covered a straight-line area of almost 1,000 meters. The *average* height of the trees was 5.1 meters.

Number Crunches

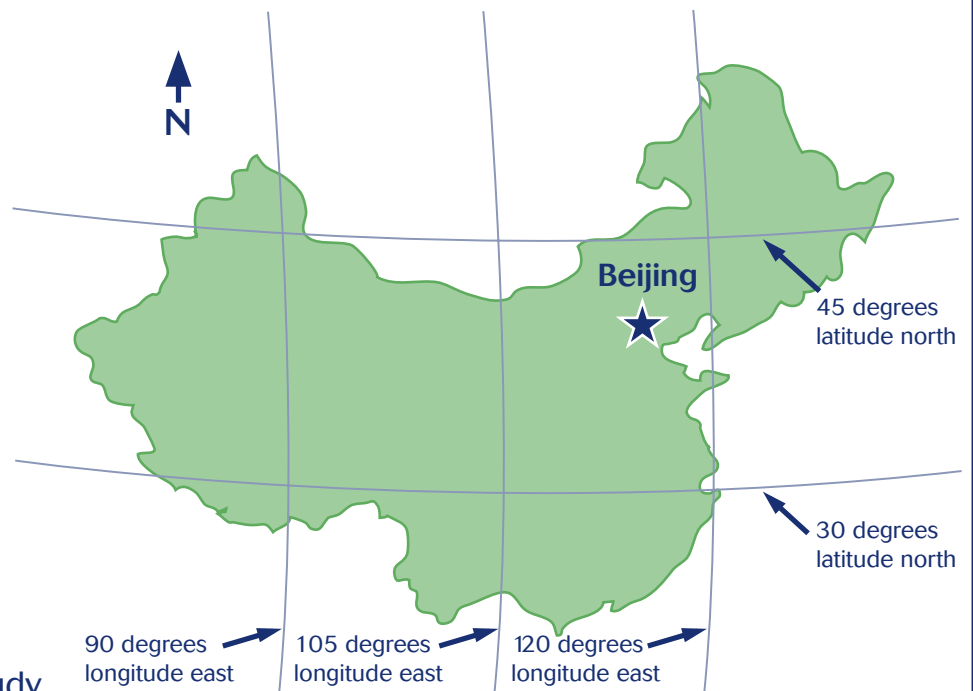🍁 To calculate how many feet 1,000 meters are equal to, multiply 1,000 by 3.280.

🍁 What was the average tree height in feet?

The scientist planned to release Asian long-horned beetles onto the trees and then track their dispersal over 16 days. Before releasing the beetles, the scientist placed a metal tag on each one (**figure 3**). The tag was tied onto the beetle with dental floss. The tag included

Figure 3. Asian long-horned beetle released on a tree. Can you see the two wires that served as antennas? Is this the same beetle or a different beetle than the one shown in figure 1? How do you know?

Figure 2. ▶ Map of China with lines of latitude and longitude. Latitude and longitude are imaginary lines drawn over the surface of Earth so places can be precisely located. Latitude lines mark the distance north and south from the equator. Longitude lines mark the distance east and west from the prime meridian, an imaginary line running through Europe and western Africa. Examine this map to see if you can locate the approximate location of this study.

N

Beijing

45 degrees latitude north

30 degrees latitude north

90 degrees longitude east

105 degrees longitude east

120 degrees longitude east

two small wires that served as *antennas*. Each beetle was also marked with a number so it could be identified. If you have not done so, read "Thinking About Science" above. This section explains that the scientist used a technology called harmonic radar to track the dispersal of the beetles.

The scientist placed between 7 and 12 beetles on the willow tree trunks every day for the first 5 days of the study. He released 55 beetles overall. Almost equal numbers of male and female beetles were released. The scientist used different willow trees each day for releasing the beetles. He recorded each beetle's number and on which tree it was released.

The scientist searched for the beetles from the 2nd day of the experiment through the last day. He used the transceiver to search for beetles in the tree canopy (**figures 4 and 5**). He also used binoculars and the naked eye to search for beetles (**figure 6**). When the scientist found a beetle, he recorded its number, sex, and location.

To determine how far a beetle traveled, the scientist summed the straight-line distance measured each time each beetle was identified (**figure 7**). Remember that the scientist also recorded the sex of each beetle so he could compare the movement of males and females.
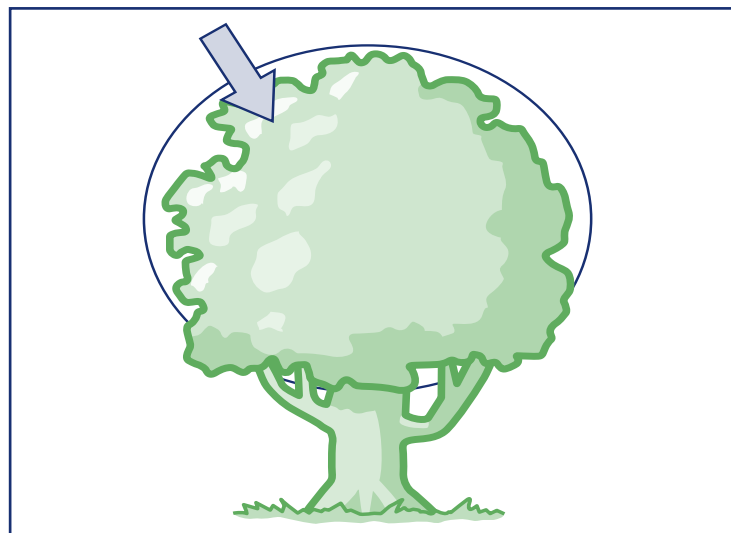
**Figure 5.** Scientist using the transceiver.

Figure 6. Scientists searching for beetles using binoculars and the transceiver.

Figure 4. Tree canopy.

Figure 7. Example of how the total distance traveled was recorded. The total distance traveled by one beetle was the sum of the distances between the grey diamonds. The diamonds represent the place where the beetle was found each day. As you can see, the beetles moved both within and between trees.

General direction of beetle movement

Beginning point

End point
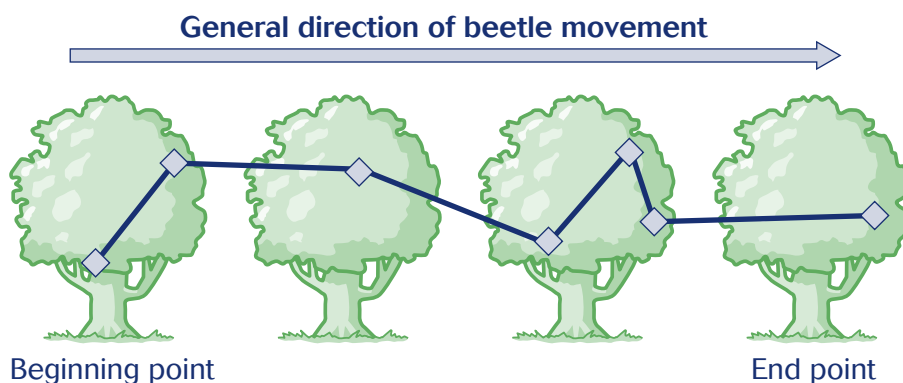
Findings

Male beetles traveled more than six times the distance of female beetles and moved twice as fast. Most females did not move from the tree on which they were released. Overall, the beetles that moved went equally in both directions (east or west) from their place of release. After they began moving in a direction, most beetles continued moving in the same direction. Of those that moved, the average distance traveled over the 16 days was about 22 meters (**table 1**).

Number Crunches

🍁 Calculate the number of feet the beetles moved by multiplying the distance in meters by 3.280.

	Gender	
	Male	Female
Average number of meters traveled per day	3.7	1.9

Table 1. Average number of meters traveled per day by male and female beetles.

The findings in this study are different from what other scientists had found about the dispersal of Asian long-horned beetles. In this study, the beetles did not travel as far as the distance other scientists had found. The scientist in this study *speculated* on the reasons for the different distances. First, the daily air temperature during this study was extremely high compared with other studies. The daily high temperature averaged 33.6 degrees Celsius.

Number Crunches

🍁 To calculate the temperature in Fahrenheit, multiply the temperature by 9/5 then add 32.

In earlier research, other scientists found that females traveled farther than males. In this study, a high percentage of female beetles did not travel at all. The scientist speculated that the female beetles in this study did not travel because they were sexually mature and ready to lay their eggs. They probably found the willow tree that they were released on was a suitable habitat for laying their eggs.

Reflection Section

🍁 Why do you think the beetles moved only either east or west and did not move north or south? (Hint: Reread the second paragraph in "Method" above.)

🍁 Do you think this study completely answers the question of how far Asian long-horned beetles travel? Why or why not?

Discussion

The scientist thinks more studies are needed to better understand the dispersal of Asian long-horned beetles. Although he found that most females did not move from the tree that they were released on, one of the females traveled more than 30 meters in a little more than a week's time. If the female beetles are not ready to lay their eggs as they probably were in this study, they may travel longer distances. As a dangerous pest of American trees, even just a few females traveling 30 meters in a week's time could pose a threat. ■

Reflection Section

🍁 In what way could a few female beetles traveling 30 meters pose a threat to American trees?

🍁 From the results of this study, what might you conclude about the dispersal of Asian long-horned beetles?

From Williams, D.W.; Li, G.; Gao, R. 2004. Tracking movements of individual *Anoplophora glabripennis* (Coleoptera: Cerambycidae) adults: application of harmonic radar. *Environmental Entomology.* 33(3): 644–649.

FACTivity

In this FACTivity, you will participate in a "rapid response" exercise. You will pretend you are scientists responding to the news of an Asian long-horned beetle invasion in your town. The method you will use is as follows:

Students will work in pairs. Each pair represents a team of entomologists who are studying the Asian long-horned beetle. Your team has just been contacted by the Department of Homeland Security. A citizen has called with a report of an Asian long-horned beetle. After doing some research, the Department of Homeland Security has traced the beetle to a shipment of goods from China. The beetle arrived in a shipping crate. It is unknown how many other beetles might be loose in your town. All that is known is that the shipment of goods from China arrived in your community 15 days ago.

Your team has been asked to help stop the spread of the Asian long-horned beetle. Using the data from this study, develop a plan for stopping the spread of the beetle. To refresh your memory, reread the "Thinking About the Environment" and "Introduction" sections. Also, you may want to review the "Findings" and "Discussion" sections.

Each team should develop a written plan for destroying the Asian long-horned beetle. You may want to use visual aids as well. Each plan should include reasons for each action based on information from this article or from other sources about the Asian long-horned beetle. Each team should present its plan to the class.

Following the presentations, hold a class discussion about the various plans. How were they similar? How were they different? The class may want to vote on the best plan for destroying the Asian long-horned beetle.

If you are a Project Learning Tree-trained educator, you may use PLT Pre K–8th Activity Guide #8, "Forest of S.T. Shrew," and Activity Guide #22, "Trees As Habitats," as additional activity resources. These activities guide the study of microhabitats and introduce trees as insect habitat.